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ABSTRACT

Six tips for increasing student problem-solving skills are offered in this teacher fact sheet. Puzzles and simulations matched to student mental maturity and general knowledge are recommended as activities for helping students think more flexibly and practice higher order thinking skills. In addition, four suggestions are given for controlling exercise difficulty level on performance assessments. (LH)

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Assessment Supplement for Teachers

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Understanding the Problem: Key to Problem-Solving Skill

Take a moment to solve this problem:[1]

Alice made six calls to Chicago totalling 42 minutes. The first minute costs 19 cents, while each additional minute costs 14 cents. That same weekend, she made nine calls to San Francisco totalling 54 minutes. For those calls, the charge for the first minute was 20 cents, with each added minute costing 5 cents.

DESCRIBE HOW YOU WOULD USE THIS INFORMATION TO ANSWER THESE QUESTIONS. YOU NEED NOT FIND THE ANSWER TO THE QUESTION.

a. On the average, how long was a call to Chicago?
b. What is the cost of an average call to Chicago?
c. What is the cost of an average call to San Francisco?
d. What is Alice's phone bill?

This seemingly typical "word" problem has an important twist to it. It's designed to get at a key issue in solving problems: Knowing what information is necessary to find a solution. The question measures students' ability to think through a problem: to identify extraneous information, to ask the right questions.

Thinking through problems may be the heart of problem solving. Too often, students seize on the first possible response. If that one doesn't work, they either give up, or become so focused on the incorrect solution that they fail to play out other alternatives.

And this difficulty is not unique to mathematics. In nationwide tests of reading skills, for example, students consistently fall short on analytical interpretation. These stumbling blocks mask a broader, more serious issue: Students' inability to master problems.

How the "Good" Problem Solvers Do It

Teachers and experts agree that specific instruction and practice in problem-solving techniques can make a difference. Good problem solvers zero in on key ideas, while poor problem solvers do not. In addition, successful problem solvers often use these tactics:

- Delaying initial judgments until the total problem has been analyzed
- Analyzing carefully to learn what the problem really means
- Eliminating extraneous information and identifying key facts
- Stating the problem in different words
- Drawing a picture or graph so the basics can be seen more clearly
- Solving a simpler version of the more complicated problem[2]

If You Like Puzzles...

Two assessment alternatives, readily adaptable to the classroom are puzzle insight tasks and problem-solving simulations. Puzzle insight problems, often mindbogglers, provide the basis for much classical research on problem solving. The anagram problem, in which the object is to unscramble letters to form a word, is one of the simplest examples. Another example, the water jar problem, calls for determining the volume of a container by dividing its contents into several smaller containers. Another puzzle problem, equally perplexing, calls for determining the heaviest of three steel balls, all the same size, but differing in weight. The balance scale can be used only *once* to find the heavy ball.

"Too often, students seize on the first possible response."

Generally, the key to solving these tasks is to think flexibly, to avoid becoming centered or "set" on a single apparent but incorrect answer. Though these tasks are mentally challenging, puzzle insight problems reveal little about the students' method of dealing with problems. Further, experience with such problems gives students an advantage over those less experienced.

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The Next Best Thing to Real Life

Simulations — including written simulations, role playing, and electronic simulations — reveal more about students' thought patterns. The math problem presented in the introduction is a form of written simulation. It approximates a real world problem and asks the student to define the problem, identify appropriate information, and figure out a solution. Simulations are easy to devise, inexpensive, and readily applied to most subjects. They have been used, for instance, in medical education, to evaluate diagnostic skills. Actors play patients, who simulate a variety of symptoms. The student's task is to diagnose the illness. Such problems have been elevated to the highest levels with electronic simulations in which computerized mannequins, serving as patients, respond in various ways to clinical "treatments."

Simulations can also be effective in the classroom. For example, students may be given details of a pressing social problem and be asked to recommend a solution. The possibilities are endless. Consider economics (personal finance problems), history (role playing historical dilemmas faced by past leaders), and sociology (role playing current social and cultural dilemmas). Problems may be presented as written simulations, or in some instances may be integrated into the emerging microcomputer technology. But these simulations are not just games; they offer real insights into development of higher order thinking.

"Good problem solvers zero in on key ideas, while poor problem solvers do not."

Problems Aren't All Alike

Problems can vary markedly in complexity — a fact that teachers should attend to carefully as they devise instructional and assessment activities. It is easier to control exercise difficulty if one remembers these principles:

- Problems which are (or can be) represented visually are easier to solve.
- Including irrelevant data makes problems more difficult.
- Problems requiring several steps are easier than single-step problems.
- Problem difficulty increases with readability level in a written simulation.

Challenging puzzle insight problems and simulations can be very stimulating. But to be effective, they must match students' mental maturity and general knowledge. Problems requiring cognitive operations beyond the developmental capabilities of young students are frustrating, and yield invalid assessment results.

If carefully selected or developed, performance assessments can serve not only to diagnose needs, but to motivate students and provide a sound basis for designing problem-solving instruction.

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[1]Adapted from Schoen, Harold L. and Theresa Oehmke. A new approach to the measurement of problem-solving skills. From *Problem Solving in School Mathematics, 1980 Yearbook*. Stephen Krulik and Robert G. Reyes (ed.) Reston, VA: National Council of Teachers of English.

[2]Sachse, Thomas P. and Larry Picus. *Teaching Problem Solving: A Research Synthesis*. Portland, OR: Goal Based Education, Northwest Regional Educational Laboratory, 1983.